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CLUB CONVERGENCE & REGIONAL SPILLOVERS IN EAST JAVA

Rumayya
Wirya Wardaya
Erlangga Agustino Landiyanto

Abstract

This study try to identify the β-convergence process among regions in East Java using panel data of 37 regencies & municipalities between 1983-2002, taking into account the presence of spatial heterogeneity and spillover effects. Detection of spatial regimes using G-I* statistics (Getis & Ord, 1995) on regional per capita GDP values in 1983 found cluster of high income regions (group of "rich") in central & eastern part of East Java, and cluster of low income regions (group of "poor") in western part. The result of OLS & GLS regression on absolute convergence model found the existence of β-divergence process of East Java in overall period (1983-2003), consistent with the σ convergence which showing upward trend (divergence). Meanwhile, the same divergence process is also found in absolute convergence equation estimated for each club, even though in slower rate than East Java divergence rate. Using the methodology proposed by Burn, Combes, & Renard (2002) this study founds the existence of negative spillover effects between regions in "rich" clubs and from "rich" clubs to the "poor" one, where the magnitude is greater in the latter case. The club of "poor" regions is diverging faster than the "rich". This finding is robust in every convergence equation (with or without the spillover effects). The lack of diversity on East Java's manufacturing industries (Santosa & Michael, 2005 and Landiyanto, 2005) seems contribute to its divergence process by engaging a competitive mode between regions.

Keywords : β-convergence, divergence, spatial regimes, spillover effects

Spatial Convergence Club & Regional Spillovers in East Java Economies

Rumayya *

Regional Economic Development Institute (REDI)
Economics Faculty of Airlangga University
Surabaya, East Java-Indonesia
roemayya@yahoo.co.id

Wirya Wardaya

Regional Economic Development Institute (REDI)
Economics Faculty of Airlangga University
Surabaya, East Java-Indonesia
wiryawardaya@yahoo.com

Erlangga Agustino Landiyanto

Alumnus Faculty of Economics Airlangga University
Surabaya, East Java-Indonesia
erlanggaagustino@yahoo.com

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* Corresponding author alternative e-mail address : rumayya@redi.or.id , lizzardiant@yahoo.com

Abstract

The aim of this study is to identify the convergence process in East Java by incorporating the presence of regional spillover effect and the club convergence using the data of 37 regions in East Java for period 1983-2002. In contrast to current practice we rejected the assumption of a single stable steady-state in favor of a multiple-regime [club] alternative in which different regional economies obey different linear convergence models when grouped according to initial conditions. Detection of spatial regimes using G-I* statistics (Getis & Ord, 1995) on regional per capita GDP values in 1983 found cluster of high income regions (group of "rich") in central & eastern part of East Java, and cluster of low income regions (group of "poor") in western part. The result of OLS & *Spatial Durbin Model* estimation on absolute convergence model does not found any convergence process in East Java regional income. The result of *Spatial Durbin Model* estimation also found that geographic spillovers between regions in East Java is localized rather than globalize (local spillovers). This shows by the fact that the coefficient of spatial lag of initial income (τ) is positive and significant in all equation, while none of the spatial lag of endogenous variable/percapita growth (ρ) is significant, which means the region which surrounded by wealthy neighbors will grow faster than the region surrounded by poor neighbors. The effect of neighbor's initial income level to the growth of a region can be a result of technological or pecuniary spillovers. This will be the situation when technology or cost of production in a region depends not just on factors within the region but also on the level of technology in the neighbors (technology is embodied in in factors of production). These effects can be consider as supply-side externalities (Vayá, López-Bazo, and Artis, 1998). Overall the findings of this study are theoretically consistent with NEG & New Growth Theory prediction that regional income inequality tends to be persistent when the geographical spillover is localized.

Keywords : *β*-convergence, global-local spillovers, convergence club

I. INTRODUCTION

The problem of regional economic convergence has been widely studied in the recent macroeconomic literature. This hypothesis is based on neo-classical 'Solow-Swan' growth models which assume constant returns to scale and decreasing marginal productivity. This models implies a long run tendency towards the equalization of per capita income levels of different geographical areas, where the growth rate of a poor region is faster than the rich region so that the poor region catches up in the long run the per capita income of the rich region. This feature corresponds to the convergence *β*-convergence concept (*Barro and Sala-I-Martin*, 1995).

The renewal interest on this issue started to emerge in 1990s initiated (at least partly) by the development of New Growth Theory and New Economic Geography (NEG), starting with the work of *Romer* (1986, 1990), *Lucas* (1988) and *Krugman* (1991). Both theories have important implications regarding the determinants of regional growth and the evolution of regional disparities. These new theories stress the significance of spillover effects and there is growing awareness that space matters for growth. Spatial effects are increasingly recognized as an important feature of regional growth processes with a basis in economic theory.

As a result of this theoretical development, current empirical work emphasizes the spatial dimension of growth and convergence. Spatial econometric methods enable us to analyze the implication of new theoretical approaches in this respect. Studies by *Rey and Montouri* (1999), *Baumont et al*. (2000), *Carrington* (2003), and *Vayá et al*. (2004) are among others aim at investigating the impact of spatial spillover effects on innovation, growth and regional disparities.

Another strand of literature considers spatial heterogeneity in connection with regional convergence. *Ertur,Le Gallo and Baumont* (2004) and *Fischer and Stirböck* (2004) investigates whether income growth of EU regions is characterised by the formation of convergence clubs. Moreover, their analyses indicate that convergence clubs exhibit specific spatial patterns. They detect different spatial regimes in Europe using exploratory spatial data analysis [ESDA].

This paper considers some of the above mentioned issues. We analyse convergence among East Java regions between 1983 and 2002. More precisely, the paper deals with the question whether convergence clubs, i.e. different spatial regimes mark the development regional income disparities in Eat Java. We follow the above mentioned studies to define spatial regimes using classification of spatial categories from exploratory spatial data analysis [ESDA] focusing on the explanatory variable that defines the initial conditions of the convergence process. We depart from new theoretical models which focus on the role played by geographic spillovers in spatial and growth mechanisms highlight the dominating growth-geographical patterns of Core-Periphery equilibrium and uneven regional development.

The rest of the paper is organised as follows. In section 2, we briefly outline the theoretical background of our empirical investigation. The main features and implications of recent theoretical models which exhibit multiple equilibria and integrate NEG and endogenous growth are summarised. In section 3 the data and spatial weights matrix are described. Empirical spesification of convergence and the spillovers effect will be explored in Section 4. The exploratory spatial data analysis [ESDA] of the initial per capita income to detect convergence club will be presented in Section 5. Section 6 will be discussed the empirical result, then we conclude with a summary of the main results in section 7.

II. THEORITICAL FOUNDATION

Convergence Frame Work

Income may differ between regions for a host of different reasons. But equally important is how such differences are predicted to evolve over time. In the standard Neoclassical model the growth of income (output per worker) depends on the growth of capital per worker and the (exogenous) rate of technical progress (or total factor income). Hence, regional differences in income growth are explained by regional differences in the rate of (exogenous) technical progress and by regional differences in the growth of the capital labor ratio. But given that the model also assumes constant returns to scale, diminishing returns to labor and capital, and complete factor mobility - including the unimpeded diffusion of technological advance – regional income disparities are predicted to narrow over time, as initially low income regions catch up with initially high income ones (*Barro and Sala-I-Martin*, 1995).

The hypothesis of convergence based on the neo-classical growth theories implies that a "poor" economy tends to grow more quickly than a "rich" economy, so that the "poor" economy catches up in the long run the level of per capita income or production of the "rich" economy. This property corresponds to the concept of β-convergence. β-convergence may be absolute (unconditional) or conditional. It is absolute when it is independent of the initial conditions. It is conditional when, moreover, the economies are supposed to be identical in terms of preferences, technologies and economic policies. The test of absolut β-convergence, usually following on the cross-sectional model :

$$\frac{1}{t}\ln\left(\frac{y_{i,t}}{y_{i,0}}\right) = \alpha + \beta \ln\left(y_{i,0}\right) + \varepsilon_i \qquad (1)$$

$$\varepsilon_i \approx N\left(0, \sigma^2 I_n\right)$$

where y_{it} represent GRD per capita in region *i* year *t,* α , β are parameter to be estimate and ε is stochastic error term.

Neoclassical growth models of regional convergence have been much researched in recent years with varying empirical results (including the empirical studies in Indonesia by *Saldanha* (2003) and *Wibisono* (2001,2003)). Another acceptable way of testing the assumption of conditional convergence is still based on the assumption of similar stationary-states using convergence clubs (*Baumont*, *et al,* 2000). (The methods to detect the convergence clubs will be discussed in **section 5**).

In endogenous growth models, on the other hand, where technical change is argued to be determined itself by the growth process, the implications for the evolution of regional variations in income over time depend on the assumptions made about the process of technical progress. For example, in the *Romer* (1986, 1990) version of the endogenous growth model, the rate of growth of technological knowledge is assumed to be a function of the growth in the numbers of workers employed in knowledge-producing activities. If it is further assumed that technological progress diffuses rapidly across geographical space, then we might expect that technical progress in any given region will depend upon the extent to which its own technology lags behind the technology of the most advanced region(s).

Low technology regions should therefore experience the fastest growth in output per worker, which means that regional convergence in income is predicted to occur in this version of the endogenous growth model. However, there is almost none empirical works that suggests that the spatial diffusion of technology is far from instantaneous as assumed in the Neoclassical model. It is well known that certain regions appear to be innovation leaders. They are the sources of basic inventions and take the lead in applying these innovations in the form of new products and services, or more efficient ways of producing existing products. It seems that technology spillovers tend to be localized, and to be an important source of geographically-concentrated externalities and increasing returns. Regional convergence in income may thus be a slow process. The more so if, the leading innovative regions also attract knowledge and highly skilled workers from other regions. Under such conditions, not only may income differences between regions persist, they may even widen over time.

Not unrelated to endogenous growth theory, the ‘New Economic Geography’ models that have become popular in recent years (see *Fujita, Krugman and Venables*, 1999; *Fujita and Thisse*, 2002), attribute regional differences in growth to localized increasing returns arising from the spatial agglomeration of specialized economic activity and the external economies and endogenous effects such localized specialization generates (accumulation of skilled labor, local knowledge spillovers, specialized suppliers and services, and so on). The existence of localized externalities, and hence the limited geographical range of knowledge spillovers, may be due to locally embedded socio-cultural, political and institutional structures and practices that can all contribute to the localization of these external economies (Martin, 2000 on *Gardiner, Martin and Tyler,* 2004). They can help to explain not only why some regions (and cities) have a higher income and growth rate than others but also why such differences might not diminish over time. Many of the ‘new economic geography’ models in fact predict a ‘core periphery’ equilibrium pattern of income (Davis and Weinstein, 2001, on *Gardiner, Martin and Tyler,* 2004).

The different prognoses of long-run trends in regional income and incomes given by these various models can be summarize as follow (*Gardiner et al,* 2004): as economic integration between regions proceeds – and trade, factor flows, and regulatory harmonization all increase – so Neoclassical models predict accelerating convergence. The endogenous growth and ‘new economic geography’ models, on the other hand predict increasing regional specialization and spatial concentration of economic activity and growth, and hence no necessary convergence (see **Table 1**).

TABLE 1 TO BE POSITIONED ABOUT HERE

<u>Geographic Spillover and Regional Growth</u>

Neoclassical model of convergence does not consider any regional external effects on growth. However, the income level of the neighbors can affecting the growth of a region, as a result of technological or pecuniary spillovers. This will be the situation when technology or cost of production in a region depends not just on factors within the region but also on the level of technology in the neighbors (technology embodied in factors of production). These effects could be consider as supply-side externalities. Then, they would appear in the aggregate production function of a region interacting with its productive factor (*Vayá, et al,* 1998).

Besides, a certain amount of the growth experienced by any regional economy may be due to a “contagious effect” where rates of growth are larger when neighbors are also growing at high rates and smaller when neighbors are stagnated or growing slowly. This effect can be thought to be related to a demand-side externality as, for instance, demand for final goods or inputs produced in a region from their neighbors. It will be consider as a positive externality when a pro-cyclical relationship in growth among neighboring economies exists (*Vayá, et al,* 1998).

Lucas (1993) on *Rey* (2001) suggests a model that allows for cross-economy interactions in the form of human capital spillovers. The presence of these spillovers (i.e., learning by doing) can radically alter the patterns of cross-economy growth from those suggested by a traditional neoclassical growth model. The basic idea is that if economies interact via human capital spillovers, and if the interacting economies become grouped, it is likely that within group spillovers will be stronger than between group spillovers. This would result in within group convergence but, potentially, divergence between groups.

<u>Club Convergence</u>

Based on previous theory, there is another class of models which predict the existence of convergence clubs. Club convergence can also be derived from growth models, such as in, which exhibit multiple steady state equilibrium. In these kinds of models, the steady state equilibrium of a region is determined by its initial conditions, and regions will converge to the same steady state, if they are characterized by similar conditions. Several approaches refer to human capital formation as a cause of club convergence. Due to social increasing returns to scale from human capital accumulation, countries or regions differing with respect to their initial level of human capital might converge to different steady state equilibrium.

Several factors such as the endowment of important factors of production (human capital, public infrastructure, R&D activity), preferences or government policies may induce convergence clubs. As there are systematic differences between agglomerations and rural peripheral regions with respect to human capital endowment, infrastructure and R&D activity, these models reinforce theoretical arguments regarding convergence clubs which correspond with spatial categories. However, the models also provide arguments for an influence of national factors as national policies or legislation (*Bräuninger and Niebuhr,* 2005).

With respect to an empirical analysis of regional growth the implications of the models stress primarily two aspects. Firstly, the theoretical models suggest that centre and periphery might not converge to the same steady state, and we should therefore check the existence of convergence clubs. Secondly, the theoretical approaches point at the significance of spillover effects and the relevance of their geographical range as regards the development of regional disparities. Geographic spillover effects might be considered explicitly by spatial regression models (*Bräuninger and Niebuhr,* 2005).

An important contribution of spatial econometrics to the empirics of growth is on the topic of spatial convergence clubs. This is the notion that groups of countries share the same steady state characteristics, and are therefore converging to the same long-run growth path. While the broader empirical growth literature has focused on the issue of club convergence among countries with similar initial values for some variables of interest, (e.g., per-capita income or human capital), the spatial econometrics literature has focused on the effects of location in determining club convergence *(Abreu, de Groot and Florax,* 2004)

There are several reasons to expect convergence clubs to have a spatial dimension. First, technology diffusion encourages convergence, and is also a function of relative location (physical distance, travel time). Second, the initial level of technology may have a spatial dimension. Third, we have seen that other types of spillovers tend to have a localized effect, contributing to convergence among countries or regions located close to each other. The concept of club convergence is related to that of spatial heterogeneity, and several studies have used spatial regimes to model it *(Abreu, de Groot and Florax,* 2004).

<u>Global-Local Spillover</u>

If we focus on geographic or regional spillover effects, some theoretical results are especially important. Geographic spillovers refer to positive knowledge external effects produced by some located firms and affecting the production processes of firms located elsewhere. Local and global geographic spillovers must be distinguished. The former means that production processes of the firms located in one region only benefit from the knowledge accumulation in this region. In this case, uneven spatial distributions of economic activities and regional growth divergence are observed. The latter means that knowledge accumulation in one region improves productivity of all the firms whatever the region where they are located (*Baumont, et al,* 2000).

A global geographic spillover effect doesn't reinforce agglomeration processes and contributes to growth convergence. Intermediary spatial ranges can be considered if the concentration of firms in one region produces both local and global knowledge spillovers of different values. Uneven or equilibrium patterns of regional growth appear according to the relative strengths of this geographic spillover in a region and between the regions (*Baumont, et al,* 2000).

In theoretical approaches that include endogenous growth in an NEG framework, growth and agglomeration of economic activities are mutually self-reinforcing processes: growth brings about agglomeration and agglomeration fosters growth (see Martin and Ottaviano 2001 on *Baumont, et al,* 2000). Models by *Fujita and Thisse* (2002) combine the Krugman core-periphery model with Romer-type endogenous growth. As a main result of corresponding approaches, growth is affected by the spatial distribution of mobile skilled workers who develop new goods in an R&D sector. More precisely, the overall growth rate of the economy depends on the distribution of R&D activity across space. Knowledge capital affecting the productivity of researchers positively is assumed to increase in each region with the interaction of all skilled workers. The interaction among researchers in turn is influenced by the spatial distribution of researchers. Proximity due to agglomeration fosters interaction and innovation.

In general, the analyses differentiate between global and local knowledge spillovers. In case of global spillover effects, i.e. patents for new goods and technological knowledge are transferred costlessly among all regions, the R&D sector is located in a single region since agglomeration forces are strong. Moreover, the industrial sector might be partly or fully agglomerated in the same region. In the model by Ottaviano and Martin (1999) on *Baumont, et al* (2000), geography will not affect growth, if spillovers are global. Determinants of growth such as the R&D cost impact on regional income differentials and therefore on the location of firms. In this framework, high growth is associated with convergence since factors that increase the growth rate also decrease income differences.

If localized knowledge spillovers are assumed, e.g. because of important tacit knowledge, R&D and industry tend to be entirely agglomerated in one region. R&D activities will move to agglomerated regions, because with local spillovers R&D costs are lowest in agglomerations where firms that produce differentiated products concentrate. Altogether, the R&D sector represents a strong centripetal force that amplifies the cumulative causation. Under specific assumptions the models imply that agglomeration fosters innovation and growth. Agglomeration of skilled workers enables them to generate higher growth and a rate of innovation. As in NEG models, agglomeration is associated with increasing disparities in regional per capita income. Growth increases with the degree of industrial agglomeration and hence diverging regional per capita income (*Bräuninger and Niebuhr,* 2005).

All these theoretical results show that geographical patterns can be ordered by economic growth processes and that they can orient regional growth patterns. Applying them to the analysis of an integrated regional space would lead to the following observations:

1. Since economic activities are unevenly distributed over space, cumulative processes of agglomeration take place and most of the economic activities tend to concentrate in a few numbers of regions.

2. Since economic growth is stimulated by geographic concentration of economic activities, patterns of uneven development are observed.
3. The shadow effect contained in the cumulative agglomeration process and the spatial ranges of geographic spillovers can now explain why rich and poor regions are or not regularly distributed. Whereas all the regions could benefit from global geographic spillovers, cumulative processes of concentration in one region empties its surroundings of economic activities. As a result, rich regions can be close with each other if geographic spillovers are global and regularly distributed among them. On the contrary, the assumption of local spillovers would explain a more regular juxtaposition of rich and poor regions.
4. Finally, since history matters through the initial conditions and the cumulative nature of both growth and agglomeration processes, the observed geographic distribution of rich and poor regions would be rather stable through time.

These persistent empirical observations lead to three types of issues. The first one refers to growth theories and investigates the convergence problem if poor regions don't catch up rich ones. The second one refers to economic geography theories and investigates the effect of geographic spillovers on growth processes to explain spatial development patterns. The third one refers to econometric methods we can use to estimate economic-geography phenomena since data are not spatially randomly distributed (*Baumont, et al*, 2000).

III. DATA AND SPATIAL WEIGTHS MATRIX

This study use data on percapita GRDP (Gross Regional Domestic Product) of each East Java's regions in logarithms over the 1983-2001 period. The sample is composed of 37 regencies (*kabupaten*) and municipialities (*kota*) which extracted from *"Jawa Timur dalam Angka"* published by Central Bureau of Statistics (BPS). For ease of calculation, the 37 regencies and municipialities is augmented to 30 regions by integrating regencies which has municipialities (7 municipialities) into a single geographic entities. This step is taken considering the fact that most municipialities are geographicaly located inside its regencies (region within region).

Spatial Weights Matrix

The spatial weight matrix is the fundamental tool used to model the spatial interdependence between regions. More precisely, each region is connected to a set of neighboring regions by means of a *purely spatial pattern* introduced *exogenously* in this spatial weight matrix $\boldsymbol{W}$. The elements of w_{ii} on the diagonal are set to zero whereas the elements w_{ij} indicate the way the region i is spatially connected to the region j. These elements are *non-stochastic, non-negative* and *finite*. In order to normalize the outside influence upon each region, the weight matrix is standardized such that the elements of a row sum up to one. For the variable y_0, this transformation means that the expression $\boldsymbol{Wy_0}$, called the spatial lag variable, is simply the weighted average of the neighboring observations. Various matrices can be considered: a simple binary contiguity matrix, a binary spatial weight matrix with a distance-based critical cut-off, above which spatial interactions are assumed negligible, more sophisticated generalized distance-based spatial weight matrices with or without a critical cut-off. The notion of distance is quite general and different functional form based on distance decay can be used (for example inverse distance, inverse squared distance, negative exponential etc.). The critical cut-off can be the same for all regions or can be defined to be specific to each region leading in the latter case, for example, to k-nearest neighbors weight matrices when the critical cut-off for each region is determined so that each region has the same number of neighbors.

This study use the traditional approach (a general spatial weight matrix) that is based on the geography of the observations, designating regions as 'neighbours' when they are share border of each other (a simple binary contiguity matrix). According to the adjacency criteria, the element of the spatial weight matrix (w_{ij}) is one if location *i* is adjacent to location *j*, and zero otherwise. For ease of interpretation, the matrix is standardized so that the elements of a row sum to one (*row-standardized*).

IV. *β*-CONVERGENCE MODELS AND SPATIAL EFFECTS

According to classification by *Abreu, de Groot and Florax* (2004) on the studies of growth and convergence in which location affects growth, vast majority of the studies (63%) fall into the standard spatial econometrics category (they follow standard spatial econometric procedures, and the emphasis is on methodology rather than on theory or policy considerations). Moreover *Abreu, de Groot* and *Florax* (2004) critised that the spatial econometrics literature on growth has tended to focus on methodological issues, and has frequently overlooked theoretical and policy considerations.

Their review found that only 11% of all studies derive their empirical models explicitly from theory. Exceptions to this rule are a number of studies on technology diffusion and spillovers. *López-Bazo et al.* (1998, 2004), is an example of a spatial econometric study of technology diffusion, applied to the regions of the European Union. The level of technology in each region is assumed to depend on the technology of its neighbours, which is in turn related to neighbours'stocks of human and physical capital. The empirical model is thus linked directly to theory, and the conclusions can give insights into the appropriateness of the theoretical model.

In their review *Abreu, de Groot and Florax* (2004) also critised the over-reliance of the literature on the spatial error (error process displaying spatial covariance with errors from different regions) and spatial lag models (including spatial lag of endogenous variabel on the right hand side) which has tended to obscure other models available to capture spatial effects. One possibility of modelling strategy they offer to capture spatial effects is the spatial cross-regressive model, which consists of including the spatial lag of one or more explanatory variables on the right hand side. Examples are *Lall and Yilmaz* (2001) and *Rumayya, Wardaya, and Landiyanto* (2005), who include the spatial lag of human capital (*Lall and Yilmaz*, 2001) and initial income (*Rumayya, Wardaya, and Landiyanto,* 2005) to measure the effects of human capital and technological/pecuniary spillovers in convergence model.

This approach has the advantage of confining the spatial effects to the neighbours of each observation (as defined by the spatial weights matrix), and of maintaining a strong link to theory. It often makes no sense (from a theoretical point of view) to consider a spatial lag model, which implies that growth in country *i* is a function of all the explanatory variables in all other countries *j* in the system. The cross-regressive model is an example of a model which is local in scope.

Based on the review of *Abreu, de Groot and Florax* (2004) this study will use the model proposed by *López-Bazo et al.* (1998, 2004) to identify the presence of convergence process and regional spillovers among East Java regions between 1983-2002. The resulting specification is of the following form:

$$\frac{1}{t}\ln\left[\frac{y_{i,t}}{y_{i,0}}\right]=\alpha+\beta\ln(y_{i,0})+\tau W\ln(y_{i,0})+\rho W\left(\frac{1}{t}\ln\left[\frac{y_{i,t}}{y_{i,0}}\right]\right)+\varepsilon_i \qquad \textbf{(2)}$$

$$\varepsilon_i \approx N\left(0, \sigma^2 I_n\right)$$

where $y_{i,t}$ represents GRP per capita in region *i* year *t*, τ and ρ are parameter of spatial lag of initial income and percapita growth to be estimated, ε_i is a stiochastic error term. There is β-absolute convergence when the estimate of β is significantly negative and positive regional spillovers if τ and ρ are significantly positive.

There are three advantages of this spesification. First, it yields some information on the nature of convergence through the β parameter once spatial effects are controlled for . Second, it able to identify the presence and magnitude of regional spillover effects in regional growth processes and differentiate two types of spatial spillover effects, which is demand and supply side externalities (*Vayá, López-Bazo, and Artis,* 1998)). Third, we can associate the structure in (2) with the typology of global and local spatial externalities introduced by *Anselin* (2003), since the structure of spesification of the model encompasses the *spatial autoregressive* and *spatial cross-regressive* model, in which the latter modeled the local spillover effect while the former is modeled the global spillover effect (*Le Sage*, 2004).

From the spatial econometrics perspectives the empirical spesification shown in (2) is similar with variant of *Spatial Durbin Model* (SDM) described by *Le Sage* (1999, p.82) due to the analogy with a suggestion by Durbin for the case of a time series model with residual autocorrelation. The basic specification of the *Spatial Durbin Model* (SDM) takes form (*Le Sage,* 1999, p.82):

$$\begin{aligned} &(I_n - \rho W)y = (I_n - \rho W)X\beta + \varepsilon \\ &y = \rho Wy + X\beta - \rho WX\beta + \varepsilon \\ &\varepsilon \approx N\left(0, \sigma^2 I_n\right) \end{aligned} \qquad \textbf{(3)}$$

We implement a variant of this model which labeled SDM (*Le Sage,* 1999, p.82):

$$\begin{aligned} &y = \rho Wy + X\beta_1 + WX\beta_2 + \varepsilon \\ &\varepsilon \approx N\left(0, \sigma^2 I_n\right) \end{aligned} \qquad \textbf{(4)}$$

Estimation of this model by Ordinary Least Squares (OLS) produces inconsistent estimators due to the presence of a stochastic regressor ***Wy*** , which is always correlated with $\boldsymbol{\varepsilon_i}$, even if the residuals are identically and independently distributed (*Anselin*, 2000). Hence it is to be estimated by the Maximum Likelihood Method (ML) or the Instrumental Variables Method (For computational details of this model using Maximum Likelihood estimates see *Le Sage* (1999, p.83-87)).

The theoretical framework outlined in **section 2** supply some hints as regards the determination of convergence clubs. They imply the non convergence of per capita income of the centre and the periphery. The concept of convergence clubs is inline with such persistent disparities. Transferred to the East Java economic landscape, the theoretical framework suggests differentiating between highly agglomerated regions, being the origin of innovation and growth, on the one hand side and rural peripheral regions where no or only little R&D takes place on the other hand. The latter regions might benefit from growth and innovation initiated in the agglomeration, but they will not be able to catch up to the income level of agglomerations if spillovers are not global.

Depart from this theoretical framework our methodology assumes that the core-periphery pattern considered by *Fujita and Thisse* (2002) does refers to the East Java economies as proposed by *Kuncoro* (2002). Club identification in this study is performed with

the help of exploratory spatial data analysis [ESDA] focusing on the explanatory variable that defines the initial conditions of the convergence process. This approach is inline to recent analyses of convergence among European regions by *Fischer and Stirböck* (2004) as well as *Ertur, Le Gallo and Baumont* (2004). These authors also apply a spatial regimes approach using exploratory data analysis [ESDA].
This technique is a convenient way of detecting spatial regimes in the data (for more details see **section 5**). The virtue of the procedure lies in its ability to uncover spatial effects and spillovers among regional economies on the basis of initial incomes.

When convergence clubs exist, one convergence equation should be estimated per club (*Dall'erba* and *Le Gallo*, 2003), since under such circumstances there might be convergence among similar types of economies (club convergence), but little or no convergence between such clubs. Our methodology to incorporate this issue is by simply estimate the spesification in (2) for each clubs identified by ESDA technique.

V. EXPLORATORY SPATIAL DATA ANALYSIS

A convergence club is a group of regional economies that interact more with each other than with those outside and that exhibit initial conditions which are near enough to converge towards the same long-run equilibrium. Unfortunately, economic theory does not provide guidance as to either the number of clubs or the way in which the explanatory variable defining the initial conditions determines clubs (*Fischer and Stirböck*, 2004). To determine those clubs, some authors select a priori criteria, like the belonging to a geographic zone or some GDP per capita cut-offs, others prefer to use endogenous methods, as for example, polynomial functions or regression trees. In the context of regional economies characterized by strong geographic patterns, like the core-periphery pattern, convergence clubs can be detected using exploratory spatial data analysis which relies on geographic criteria (*Dall'erba and Le Gallo*, 2003; *Fischer*, *Manfred and Stirböck,* 2004).

Two statistical measures of exploratory spatial data analysis [ESDA] which this study use to determine spatial clubs are *Moran* scatter plot (*Ertur*, *Le Gallo and Baumont*, 2004) and *Getis-Ord* statistics (*Fischer*, *Manfred and Stirböck,* 2004). Focusing on the explanatory variable that defines the initial conditions of the convergence process, these techniques are convenient way of detecting spatial regimes in the data. The virtue of the procedures lies in its ability to uncover spatial effects and spillovers among regional economies on the basis of initial incomes.

Using the spatial weight matrices previously described, the first step of our analysis is to detect the existence of spatial heterogeneity in the distribution of regional per capita GDP 1983. In that purpose, we use the G-I* statistics developed by *Ord and Getis* (1995). These statistics are computed for each region and they allow detecting the presence of local spatial autocorrelation: a positive value of this statistic for region *i* indicates a spatial cluster of high values, whereas a negative value indicates a spatial clustering of low values around region *i*. Based on these statistics, we determine our spatial regimes, which can be interpreted as spatial convergence clubs, using the following rule: if the statistic for region *i* is positive, then this region belongs to the group of "rich" regions and if the statistic for region *i* is negative, then this region belongs to the group of "poor" regions. The statistic allows to identify spatial regimes in the data by use of the concept called proximal space (*Getis and Ord,* 1992 and *Ord and Getis* 1995) and is formally defined as:

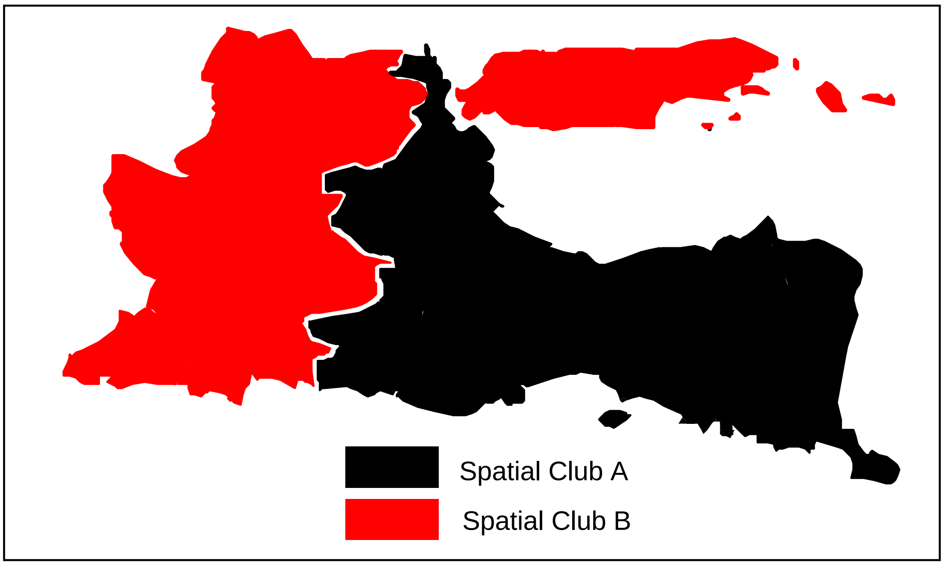
$$Gi = \sum_{j}^{n} w_{ij}\left(x_j - \bar{x}_i\right) \Big/ [S_i \sqrt{\frac{w_i(n-1-w_i)}{n-2}}] \quad \textbf{(5)}$$

where x_i is the observed value at location i, $\bar{x}_i = \frac{1}{n-1}\sum_{j,j=1}^{n} x_j$, (w_{ij}) is a symmetric binary spatial weight matrix $w_i = \sum_{j,j\neq 1}^{n} w_{ij}$ and $S_i^2 = \frac{1}{n-1}\sum_{j,j\neq 1}^{n}\left(x_j - \bar{x}_i\right)^2$.

The G-I* statistics can be used to identify spatial agglomerative patterns with high-value clusters or low-value clusters. However, this statistic cannot identify the negative spatial association (i. e., high value with surrounding low values and vice versa).

The result of this procedure outlined in **Figure 1**. Two spatial regimes, where richer regions tend to be clustered in club A and poorer regions in club B. This geographical pattern can be seen as representative of the well-known core-periphery framework (*Krugman* 1991; *Fujita* et al., 1999).

Figure 1. Two spatial regimes identified by using G-I* Statistics [per capita GRDP in 1983]



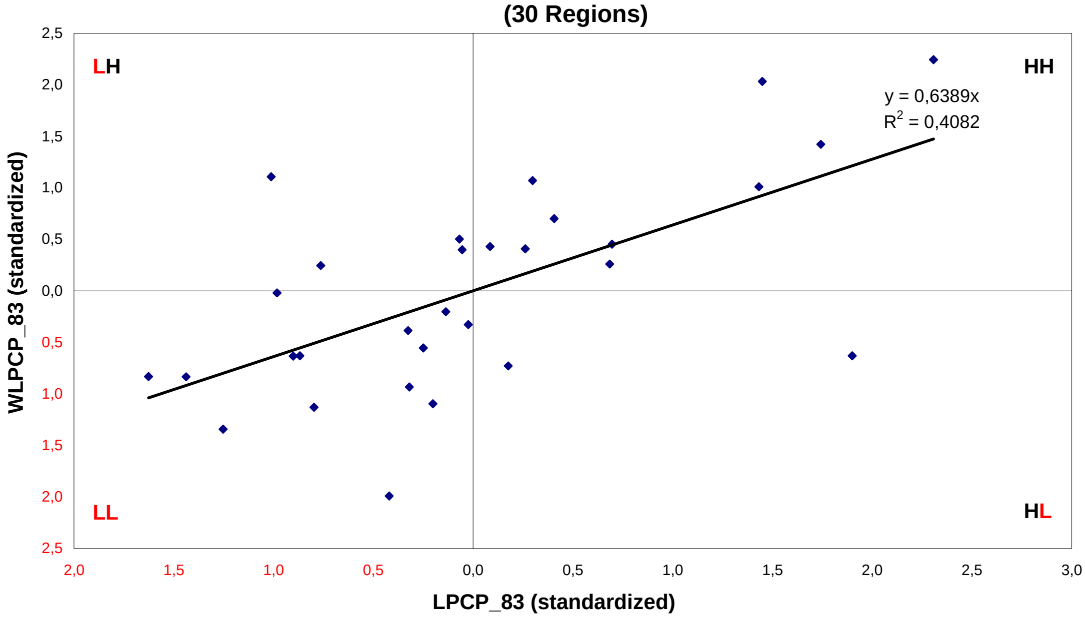
Spatial club A consists of 14 regions in central & eastern part of East Java includes : Blitar, Malang, Lumajang, Jember, Banyuwangi, Bondowoso, Situbondo, Probolinggo, Pasuruan, Sidoarjo, Mojokerto, Jombang, Gresik, Surabaya. Meanwhile *Spatial club B* is made up of 16 regions in western part of East Java includes : Pacitan, Ponorogo, Trenggalek, Tulungagung, Kediri, Nganjuk, Madiun, Magetan, Ngawi, Bojonegoro, Tuban, Lamongan, Bangkalan, Sampang, Pamekasan, Sumenep.

The next step of our analysis is using the Moran scatter plot to detect the existence of spatial heterogeneity in the distribution of East Java regional per capita GDP 1983. This measures has advantage from the G-I* statistics because it can identify the negative spatial association (i. e., high value with surrounding low values and vice versa) which G-I* statistics cannot detect (**Figure 2** outline the result). The Moran scatterplot is illustrative of the complex interrelations between global spatial autocorrelation and spatial heterogeneity in the form of spatial regimes. Global spatial autocorrelation is reflected by the slope of the regression line of

***Wy*$_0$** against ***y*$_0$**, which is formally equivalent to the Moran's I statistic for a row standardized weight matrix (*Ertur, Le Gallo and Baumont,* 2004).

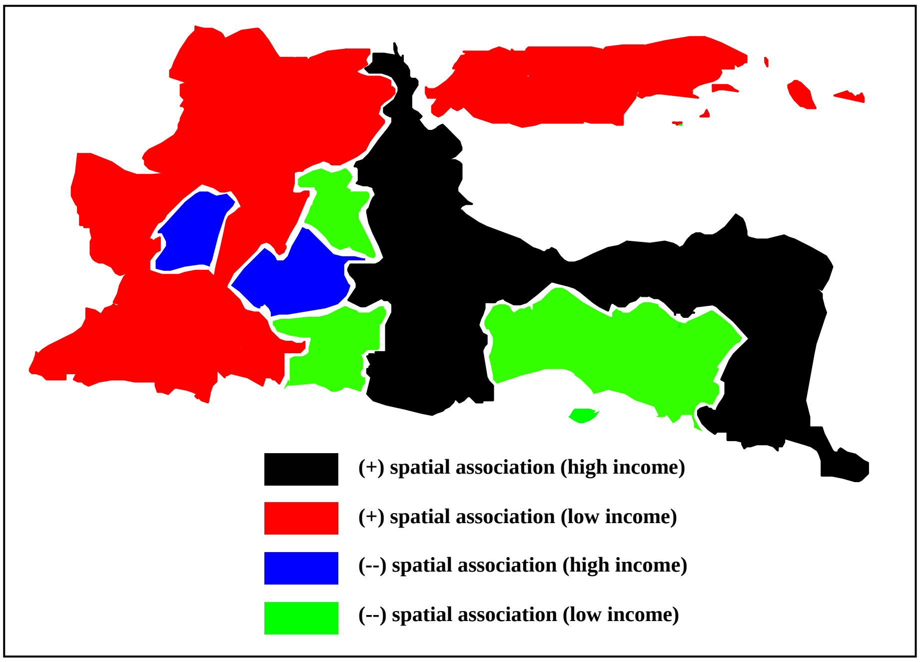
The Moran scatterplot displays the spatial lag ***Wy*$_0$** against ***y*$_0$**, both standardized. The four different quadrants of the scatterplot correspond to the four types of local spatial association between a region and its neighbors (**Figure 3** outline the result): (HH) a region with a high value surrounded by regions with high values, (LH) a region with a low value surrounded by regions with high values, (LL) a region with a low value surrounded by regions with low values, (HL) a region with a high value surrounded by regions with low values. Quadrants HH and LL refer to positive spatial autocorrelation indicating spatial clustering of similar values (positive spatial association) whereas quadrants LH and HL represent negative spatial autocorrelation indicating spatial clustering of dissimilar values (negative spatial association). The Moran scatterplot may thus be used to visualize atypical localizations in respect to the global pattern, i.e. regions in quadrant LH or in the quadrant HL. A four-way split of the sample based on the two control variables, initial per capita GDP and initial spatially lagged per capita GDP, allowing for interactions between them, can therefore be based on this Moran scatterplot.

Figure 2. Moran Scatterplot for LPCP_83 (30 Regions)



The result of both measures suggests some kind of spatial heterogeneity in the East Java regional economies, the convergence process, if it exists, could be different across regimes. However this study will only consider the spatial clubs constituted by the G-I* statistics, since using Moran scatterplots to determine the spatial clubs imply that the "*atypical*" regions (regions in quadrant LH and the quadrant HL) must be dropped out of the sample (*Dall'erba and Le Gallo,* 2003), which means 6 regions in this study (that is 20% from observation!!). Therefore this study decide that the use of Getis-Ord statistics is more appropriate in order to be able to work with the entire sample.

Figure 3. Spatial regimes identified by using Moran Scatter Plot
[per capita GRDP in 1983]



VI. <u>ESTIMATION RESULT</u>

The estimation results for the classical convergence in equation (1) as well as for the estimation for each clubs are summarized in **Table 2**. The table shows that the coefficient of the initial income level is positively significant in the β-convergence model for overall East Java region and spatial club A (the core-rich club) at 5%, while the same parameter is not significant for spatial club B (the periphery-poor club) even in the level of 10%. This findings shows that there is no support for the hypothesis of absolute β-convergence, in fact the result imply the existence of divergence process (widening income inequality) among regions in East Java and among the regions in the spatial club A. The insignificance of the β-convergence parameter estimation result for spatial club B in **Table 2** also shows how income inequality in spatial club B is relatively persistence.

However, it may arise from misspecification of the model from the present of spatial effect due to geographical spillovers between regions. To address this problem the model is developed to be able to incorporate the spatial effect based on the model specification proposed by *López-Bazo et al.* (1998, 2004). The spatial effect is introduced to the model by incorporating the spatial lag of initial income and endogenous variable (*Spatial Durbin Model*) which is specified in equation **(2)**. This procedure is taken since Moran scatter plot in **Figure 3** shows the existence of a substantial level of spatial dependence among regions in East Java.

TABLE 2 TO BE POSITIONED ABOUT HERE

Table 3 reports the estimation result for *Spatial Durbin Model* estimated with *Maximum Likelihood* which obtained using *MATLAB Spatial Econometrics Toolbox* from www.spatial-econometrics.com. Estimation of *Spatial Durbin Model* of absolute β-convergence is shown in **Table 3** shows that none of the coefficient of β-convergence for convergence equation is significant in all equation. These findings confirm that there is no supporting statistical evident of income convergences towards a single steady state among East Java regions, even after we control for the presence of regional spillover effect. However, the performance measures seem to favor the *Spatial Durbin Model* rather than the non-spatial absolute β-convergence model, both in the overall convergence estimation and the club convergence estimation.

TABLE 3 TO BE POSITIONED ABOUT HERE

For the coefficient controlling regional spillover East Java, the estimation result in **Table 3** shows that only the spatial lag of initial income (τ) is positive and significant in all equation, while none of the spatial lag of endogenous variable/percapita growth (ρ) is significant in every equation. This means that per capita growth of regions in East Java is more affected (positively) by initial income of their neighbors rather than their own initial income or the growth level of their neighbors.

Based on theoretical foundation and model formulation discussed in previous section we can conclude the estimation result in **Table 3** as an empirical evidence that regional spillover among regions in East Java is tend to be localized than globalize, therefore explain why the *Spatial Durbin Model* in our findings failed to identify the convergence process among East Java economies. This conclusion seems theoretically consistent with NEG and New Growth Theory framework that regional income inequality tends to be persistent when the geographical spillover is localized rather than globalize.

The estimation result in **Table 3** can also interpreted as showing that the supply side externalities (technological or pecuniary spillovers) is much more relevant in explaining the growth process in East Java economies rather that the demand side externalities. This will be the situation when technology or cost of production in a region depends not just on factors within the region but also on the level of technology in the neighbors, since technology is embodied in in factors of production (*Vayá, López-Bazo, and Artis,* 1998).

VII. CONCLUSION

The paper has attempted to look for the evidence of regional income convergence in the East Java from the neoclassical, NEG and New Growth Theory perspectives. The focus of this study is to identify the convergence process in East Java by incorporating the presence of regional spillovers effect and the club convergence in East Java. In contrast to current practice we rejected the assumption of a single stable steady-state in favor of a multiple-regime [club] alternative in which different regional economies obey different linear convergence models when grouped according to initial conditions. The use of the Getis-Ord statistics produced a grouping that seems overall quite reasonable with the data available rather than Moran scatter plot approach.

There are four major lessons to be gained from the paper. *First*, there is no evidence for unconditional β-convergence in East Java for the time period of observation, which means the regional disparities in East Java economies is tend to be persistence. *Second*, regional spillovers effect seems to have a significant contribution in explaining regional income growth and disparities in East Java. Moreover, this study found how the regional spillovers in East Java is tends to be localized than globalize, which is theoretically consistent with NEG & New Growth Theory prediction that regional income inequality tends to be persistent when the geographical spillover is localized.

Third, based on the *Vayá, López-Bazo,* and *Artis* (1998) formulation this study also illustrates how the supply side externalities are more relevant in explaining the regional growth in East Java rather that the demand side externalities. This is shown by the fact that the spatial lag of initial income is significant in all equation while none of the spatial lag of percapita growth is significant in the *Spatial Durbin Model* estimation result. The effect of income level of neighbors to the growth of a region can be a result of technological or pecuniary spillovers. This will be the situation when technology or cost of production in a region depends not just on factors within the region but also on the level of technology in the neighbors (technology is embodied in in factors of production). This result also imply that the region which surrounded by wealthy neighbors will grow faster than the region surrounded by poor neighbors.

Last but not least, based on the findings of this study the East Java provincial government must play a greater role in facilitating regional economic policy coordination among regional government in East Java (regencies and municipialities), especially between region that share common border, since the regional spillover in East Java is tend to be localized.

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Table 1: The Summary of Convergence Framework from Neoclassical Growth Theory, Endogenous Growth Theory and NEG Models

Theory	Source of regional income differences	Evolution of regional income differences
Neoclassical Growth Theory	Regional differences in income due to different factor endowments, and especially differences in capital/labour ratios and technology	Assumes constant returns to scale;diminishing returns to factors of production; free factor mobility and geographical diffusion of technology, so that low income regions should catch up with high income one; ie regional convergence in income
Endogenous Growth Theory	Regional differences in income due to differences in capital/labour ratios, knowledge base and proportion of workforce in knowledge producing industries	Implications for regional income evolutions depends on extent to which low technology regions catch up with high technology regions,and this on degree of geographical diffusion of technology and knowledge, and flows of knowledge workers. The more knowledge/ technology spillovers are localised, and the more knowledge workers move to leading technology regions the more income differences between regions will persist, or even widen.
New Economic Geography Models	Spatial agglomeration/ specialisation/clustering are key sources of externalities and increasing returns (labour,knowledge spillovers,specialist suppliers, etc) that give local firms higher income	Economic integration (trade, factor flows) increases tendency to spatial agglomeration and specialisation of economic activity, leading to 'core-periphery' equilibria and persistent regional differences in income.

From: **Gardiner, Martin & Tyler (2004)**

Table 2: Convergence Regression Result for 30 East Java Regions, 1983-2002.
(The Classical Convergence Model)

	The Classical Convergence Model [OLS]	Club A Classical Convergence Model [OLS]	Club B Classical Convergence Model [OLS]
Parameter Estimates			
(*p*-values in bracket)			
α	**-0.250122**	**-0.355020**	-0.108599
	(0.039604)	**(0.056487)**	(0.623490)
β	**0.022676**	**0.030884**	0.011344
	(0.019411)	**(0.036229)**	(0.521946)
Performance Measures			
R^2	0.1801	0.3165	0.0299
Log-likelihood	83.69624	41.13786	43.40820
Sigma sq.	0.0002	0.0002	0.0003

Notes: all calculation conducted with MATLAB Spatial Econometrics Toolbox from www.spatial-econometrics.com

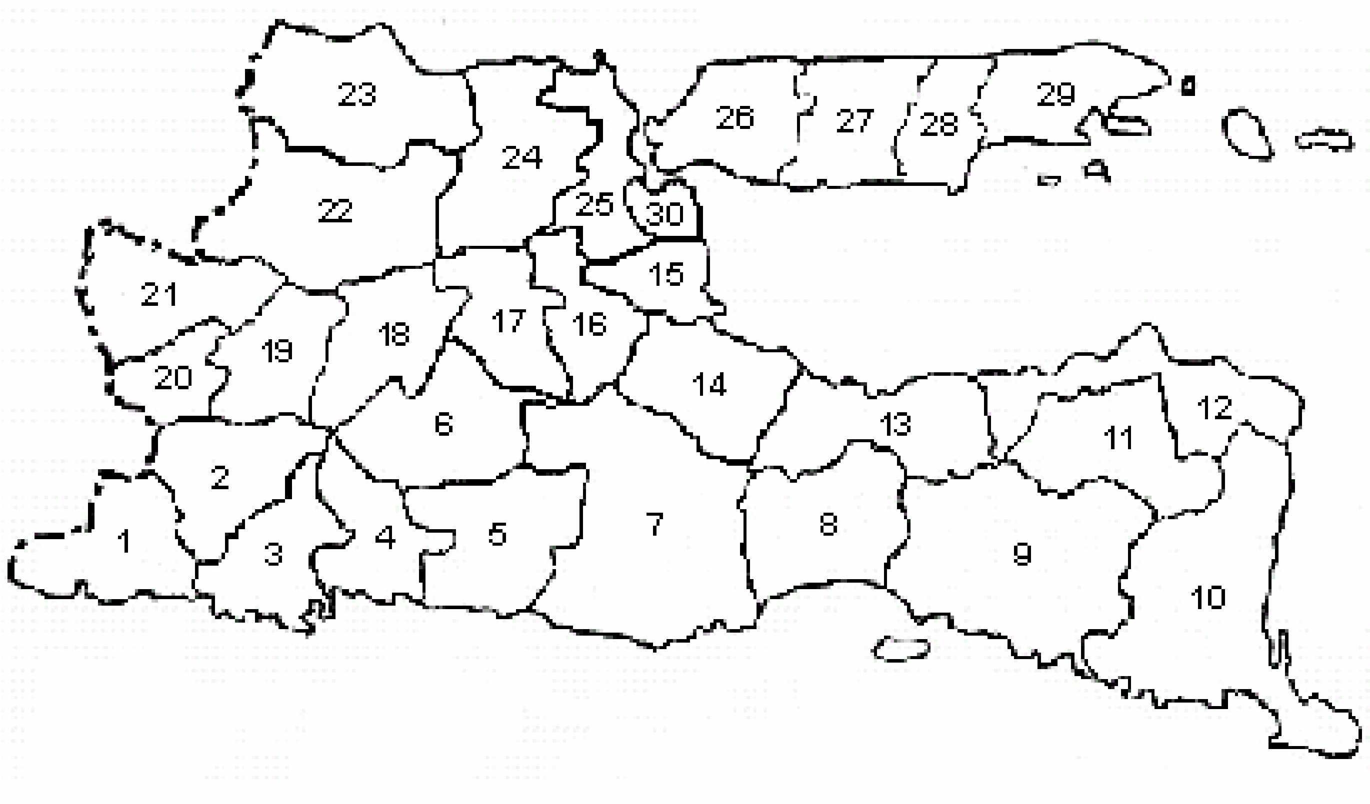
Table 3: Convergence Regression Result for 30 East Java Regions, 1983-2002.
(The Spatial Durbin Model)

	Spatial Durbin Convergence Model [ML]	Club A Spatial Durbin Convergence Model [ML]	Club B Spatial Durbin Convergence Model [ML]
Parameter Estimates			
(*p*-values in brackets)			
α	**-0.432190**	**-1.231332**	**-0.886879**
	(0.009137)	**(0.000016)**	**(0.056309)**
β	0.005633	0.005543	0.011735
	(0.595861)	(0.655864)	(0.436833)
ρ	0.174997	-0.268985	0.012965
	(0.415723)	(0.387349)	(0.962239)
τ	**0.030927**	**0.094164**	**0.061909**
	(0.046262)	**(0.000017)**	**(0.063264)**
Performance Measures			

Adj-R^2	0.2388	0.6655	0.0826
Log-likelihood	93.795196	51.84559	50.548822
Sigma sq.	0.0002	0.0001	0.0002

Notes: all calculation conducted with MATLAB Spatial Econometrics Toolbox from www.spatial-econometrics.com

Figure 4. East Java Regions by Geographic Zone



01_Pacitan	07_Malang	13_Probolinggo	19_Madiun	25_Gresik
02_Ponorogo	08_Lumajang	14_Pasuruan	20_Magetan	26_Bangkalan
03_Trenggalek	09_Jember	15_Sidoarjo	21_Ngawi	27_Sampang
04_Tulungagung	10_Banyuwangi	16_Mojokerto	22_Bojonegoro	28_Pamekasan
05_Blitar	11_Bondowoso	17_Jombang	23_Tuban	29_Sumenep
06_Kediri	12_Situbondo	18_Nganjuk	24_Lamongan	30_Surabaya